ATTACHMENT 3

a) Machine Parameter Data Set

DELPHI Automotive Systems

Ron J. Krefta

11/09/99 02:19:14 PM

To: John A MacBain
Subject: Data for Yilmaz

Please find attached an Excel file with data to meet the request of Yilmaz for machine electrical parameters for the Renault Scenic 42 V generator. Data were generated using the "known" program (with the help of Mike Bradfield in supplying the needed geometry files), with some program modifications to calculate field inductance and synchronous inductance.

Field inductance was calculated from the open circuit flux such that
Lf = N phi / Ifield
where N is the number of field turns, phi is the open circuit flux in the rotor core, and Ifield is the field current.

Synchronous inductance was calculated from the machine phasor diagram, knowing the angle of the field EMF (as opposed to airgap EMF) to current and the real voltage component such that
w Lss Ia = Vind = Vreal*tan(gamma)
where w is the electrical frequency in rad/sec, Lss is the synchronous inductance, Ia is the phase current, Vind is the inductive component of voltage, Vreal is the real component of voltage, and gamma is the angle between the field EMF and the current.

The data show the non-linear trend of machine parameters on both field current and stator current. While the data are by no means comprehensive, they do provide a flavor for the non-linear relationships and should allow for Yilmaz to get started on his simulation work.

A good explanation of the nomenclature which I loosely followed can be found in "Electric Machinery", Fitzgerald, Kingsley, & Umans, Forth Edition, page 316-317.

If you find fault with my numbers, please let me know so we can forward Yilmaz updated information.

Thank you.

rjk

renault_scenic.xls

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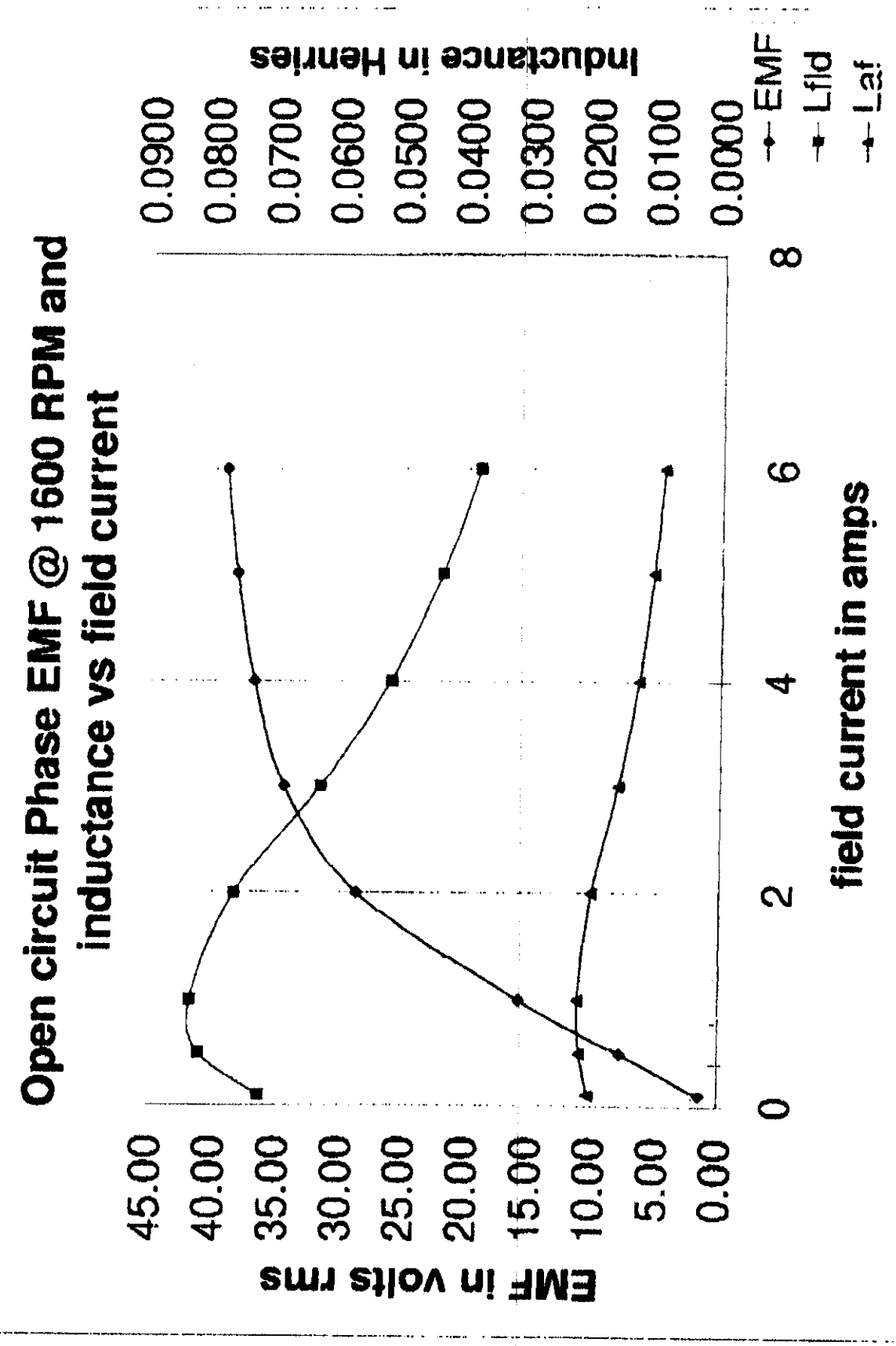
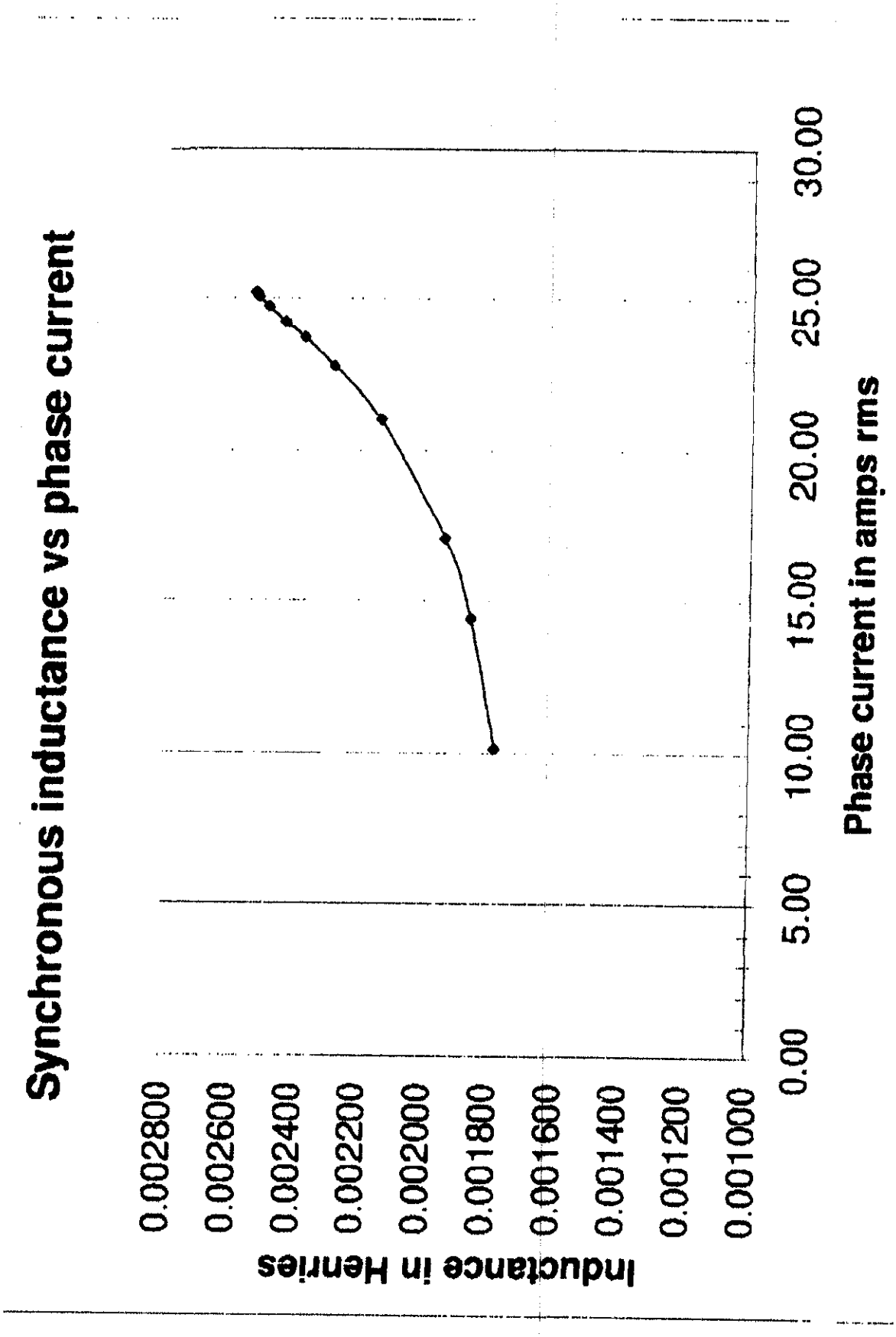
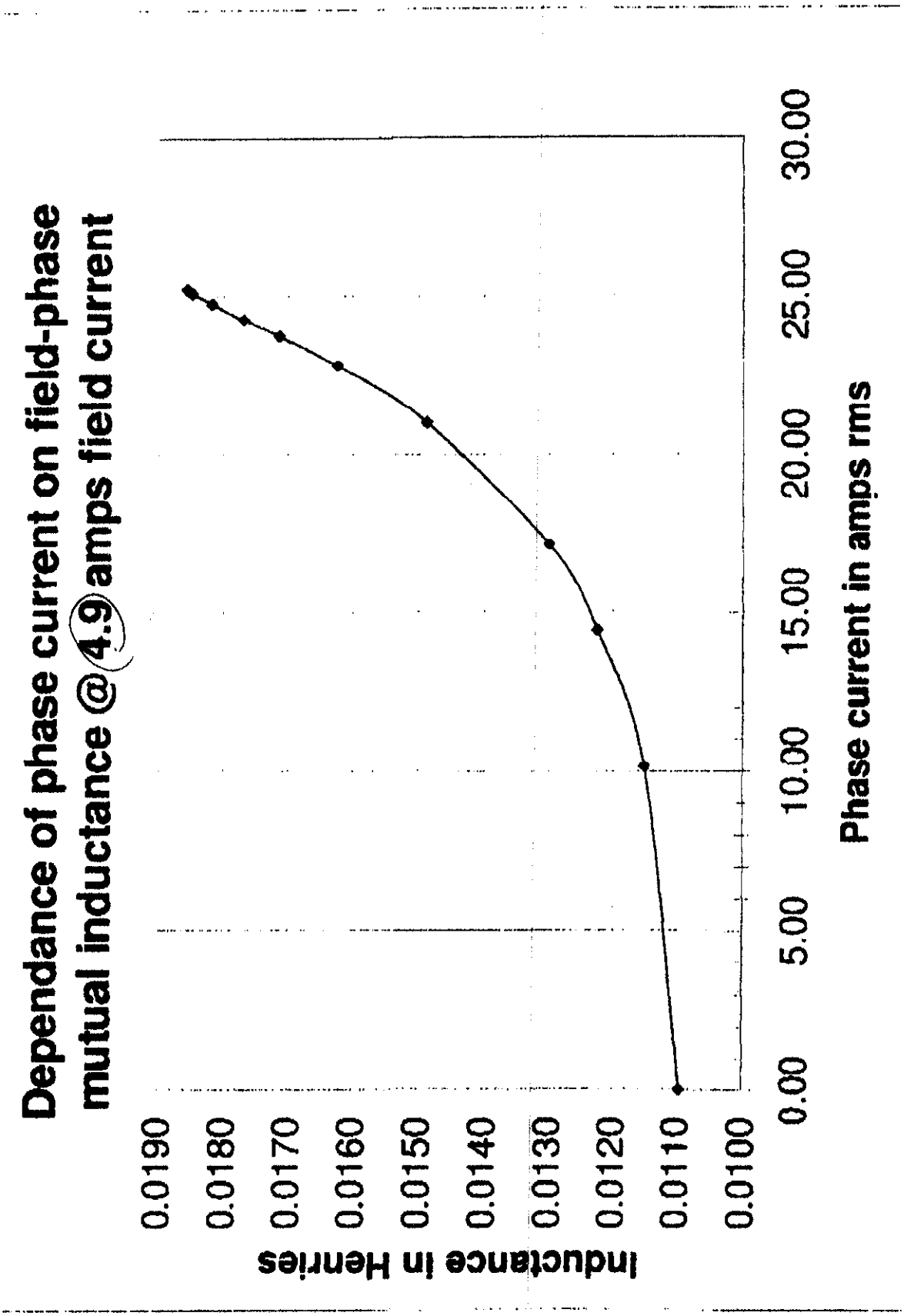

Open circuit Phase EMF @ 1600 RPM and
inductance vs field current
EMF in Volts rms
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Inductance in Henries
0.0900
0.0800
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
0
2
4
6
8
field current in amps
EMF
Lfld
Laf


Synchronous inductance vs phase current
Inductance in Henries
0.002800
0.002600
0.002400
0.002200
0.002000
0.001800
0.001600
0.001400
0.001200
0.001000
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Phase current in amps rms

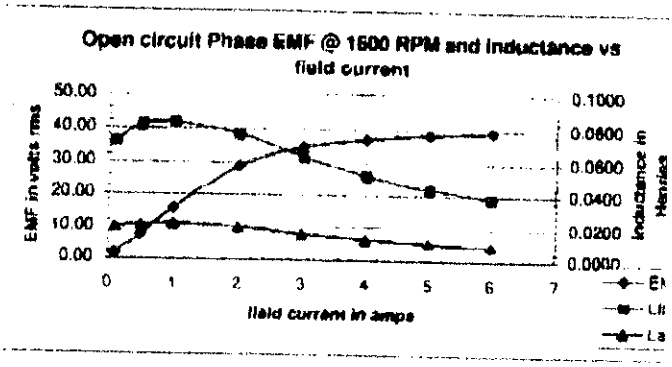

Dependance of phase current on field-phase mutual inductance @ 4.9 amps field current
Inductance in Henries
0.0190
0.0180
0.0170
0.0160
0.0150
0.0140
0.0130
0.0120
0.0110
0.0100
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Phase current in amps rms

42 volt generator parameter data

rjk 09Nov99

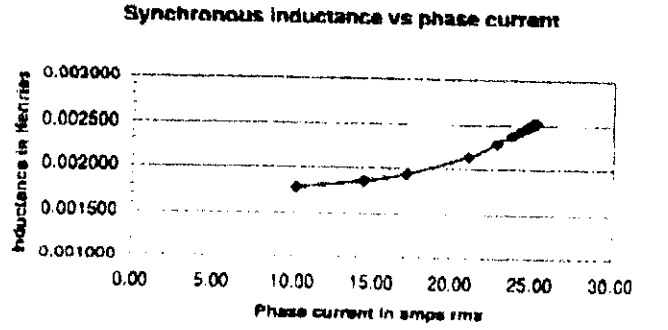
Phase EMF, Field self inductance, field to phase mutual inductance
1500 RPM

Field Current amps DC	Phase EMF rms volts	Field inductance Henries	Field-phase inductance Henries
0.1	1.45	0.0726	0.0205
0.5	7.78	0.0819	0.0218
1	15.79	0.0833	0.0222
2	28.69	0.0766	0.0202
3	34.48	0.0632	0.0162
4	36.91	0.0521	0.0130
5	38.26	0.0441	0.0108
6	39.12	0.0382	0.0092



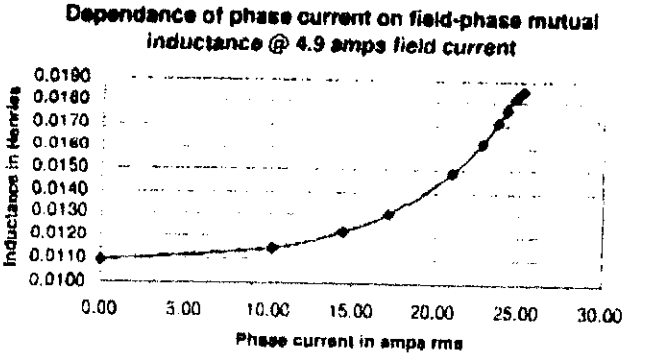
Phase synchronous inductance and phase leakage inductance

Phase Current rms Amps	Synchronous Inductance Henries	Leakage Inductance Henries	Gap Inductance Henries
10.15	0.001779	0.000550	0.000820
14.41	0.001857	0.000550	0.000871
17.12	0.001938	0.000550	0.000926
21.00	0.002139	0.000550	0.001059
22.78	0.002285	0.000550	0.001157
23.71	0.002380	0.000550	0.001221
24.24	0.002440	0.000550	0.001260
24.74	0.002491	0.000550	0.001294
25.07	0.002524	0.000550	0.001316
25.20	0.002533	0.000550	0.001322



Dependancy of field-phase mutual inductance on stator current

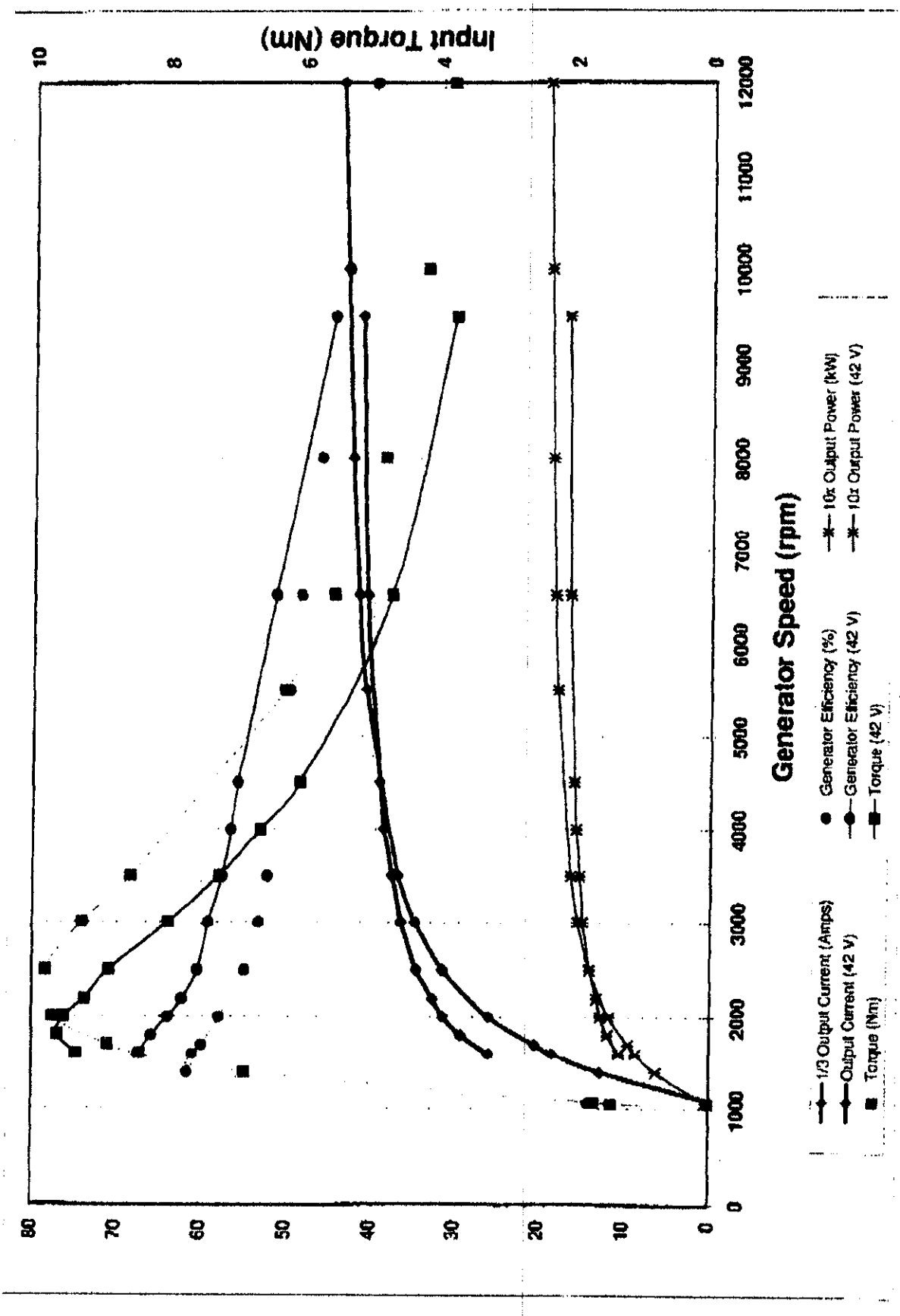
Field Current amps DC	Generator Speed RPM	Phase EMF rms volts	Phase Current rms Amps	Field-phase inductance Henries
4.9	1600	38.2	0.00	0.0110
4.9	1600	40.1	10.15	0.0115
4.9	1600	48.0	14.41	0.0122
4.9	2000	56.6	17.12	0.0130
4.9	2500	81.0	21.00	0.0149
4.9	3000	106.1	22.78	0.0162
4.9	3500	130.6	23.71	0.0171
4.9	4000	154.1	24.24	0.0177
4.9	5000	197.8	24.74	0.0182
4.9	6500	261.5	25.07	0.0185
4.9	8000	323.4	25.20	0.0186



Resistances

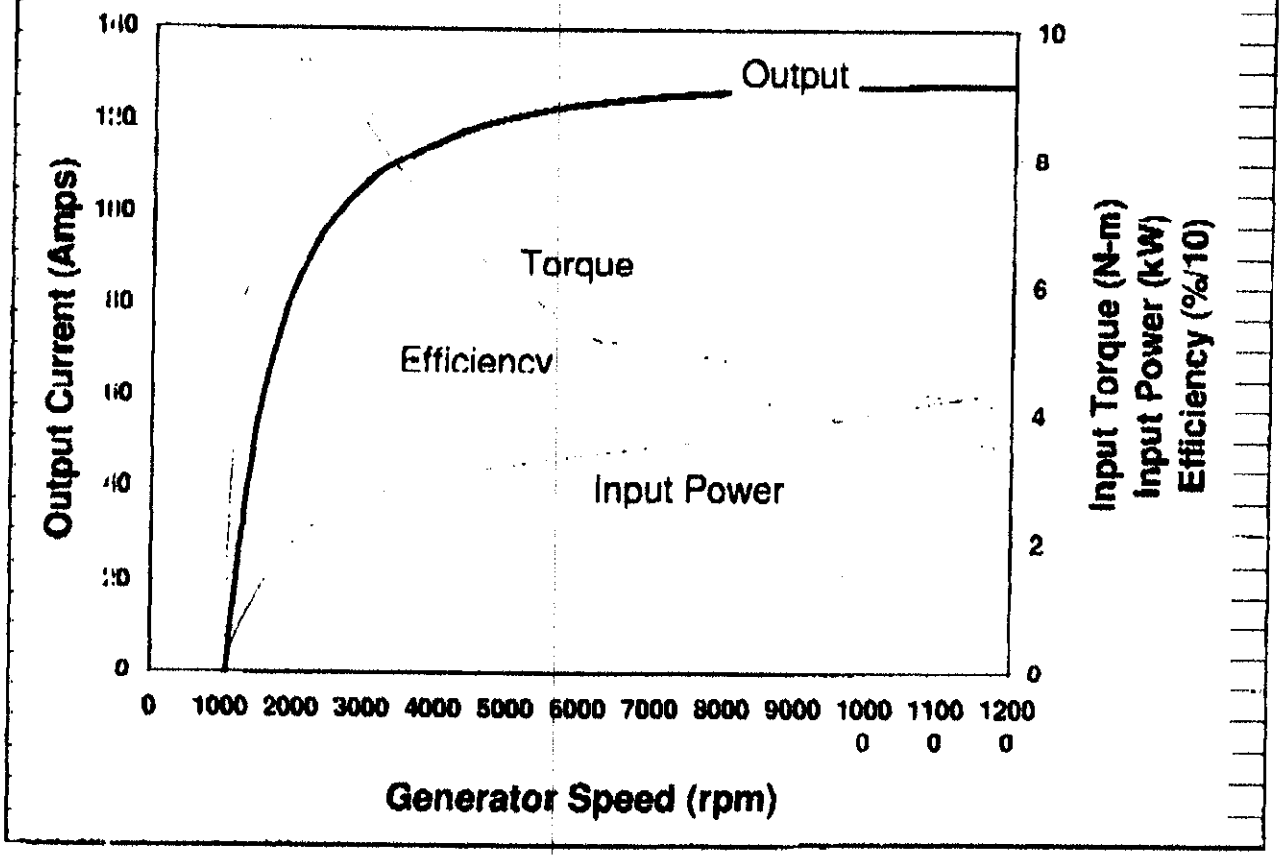
Phase resistance ohms 25 deg C	Field resistance ohms 25 deg C
0.029	2.055

AD244 vs. AF244



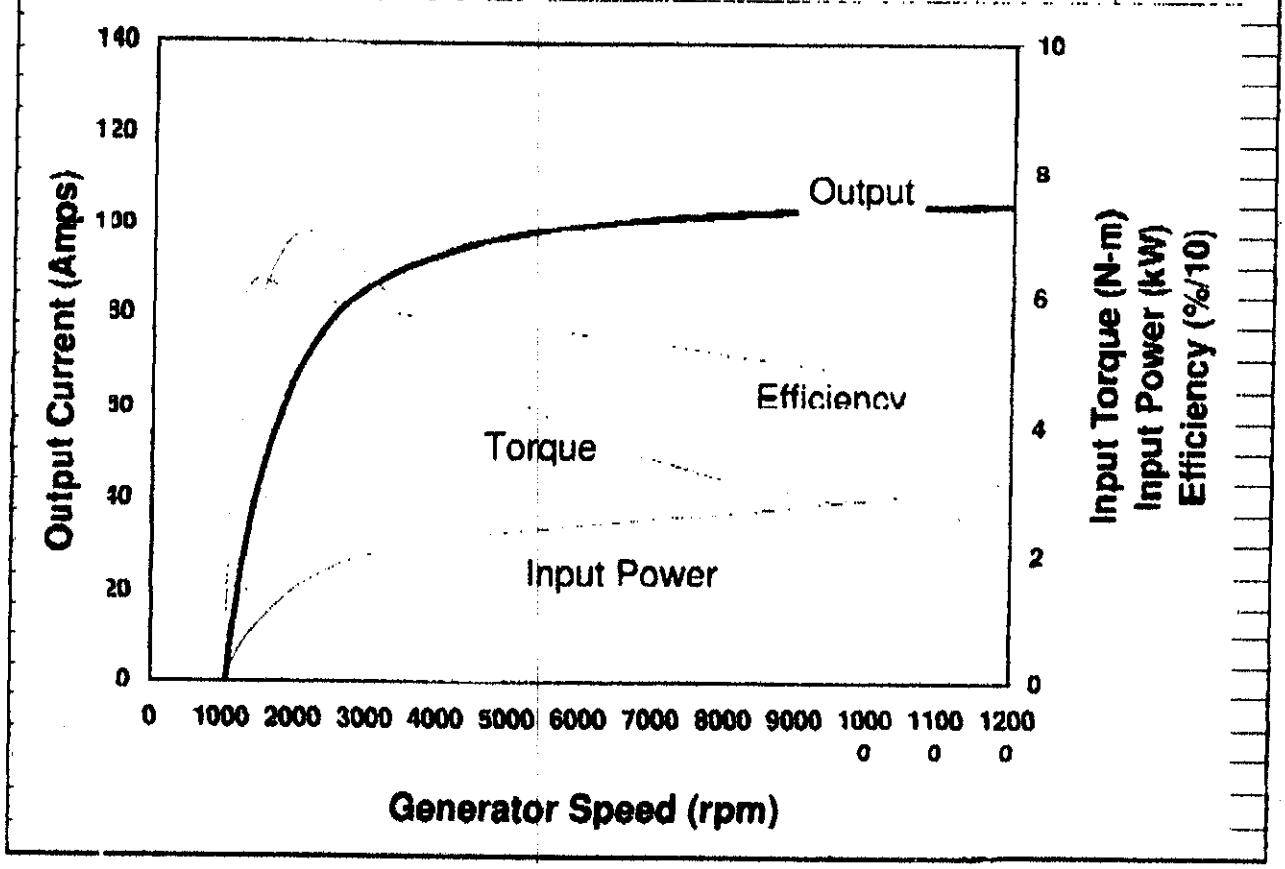
27C CURVE

K590364	14.00 V		27 C				02DE98
	Shaft Speed (grpm)	Output Current (amps)	Field Current (amps)	Input Torque (lb-in)	Input Torque (N-m)	Input Power (kW)	Output Power (watts)	Generator Efficiency (%/10)
Cut-In >	1062	0.0	4.88	14.1	1.59	0.1772	0.0	0
2 Amp >	1075	2.0	4.87	16.5	1.86	0.2099	28.0	1.334
	1200	21.5	4.86	39.3	4.44	0.5580	301.0	5.395
	1400	45.3	4.84	62.5	7.06	1.0352	634.2	6.126
	1600	62.4	4.82	75.3	8.51	1.4254	873.6	6.129
	2000	83.7	4.83	83.7	9.46	1.9805	1171.8	5.917
	2500	98.1	4.88	81.3	9.19	2.4047	1373.4	5.711
	3000	106.6	4.95	75.2	8.50	2.6691	1492.4	5.591
	3500	111.9	4.98	68.6	7.75	2.8407	1566.6	5.515
	4500	118.7	5.11	58.1	6.56	3.0933	1661.8	5.372
	5500	122.6	5.17	50.2	5.67	3.2666	1716.4	5.254
	6500	124.8	5.18	44.3	5.01	3.4068	1747.2	5.129
	8000	126.5	5.19	38.6	4.36	3.6535	1771.0	4.847
	10000	127.7	5.16	33.9	3.83	4.0108	1787.8	4.458
	12000	128.1	5.13	30.9	3.49	4.3870	1793.4	4.088
	15000	126.9	5.02	28.5	3.22	5.0578	1776.6	3.513



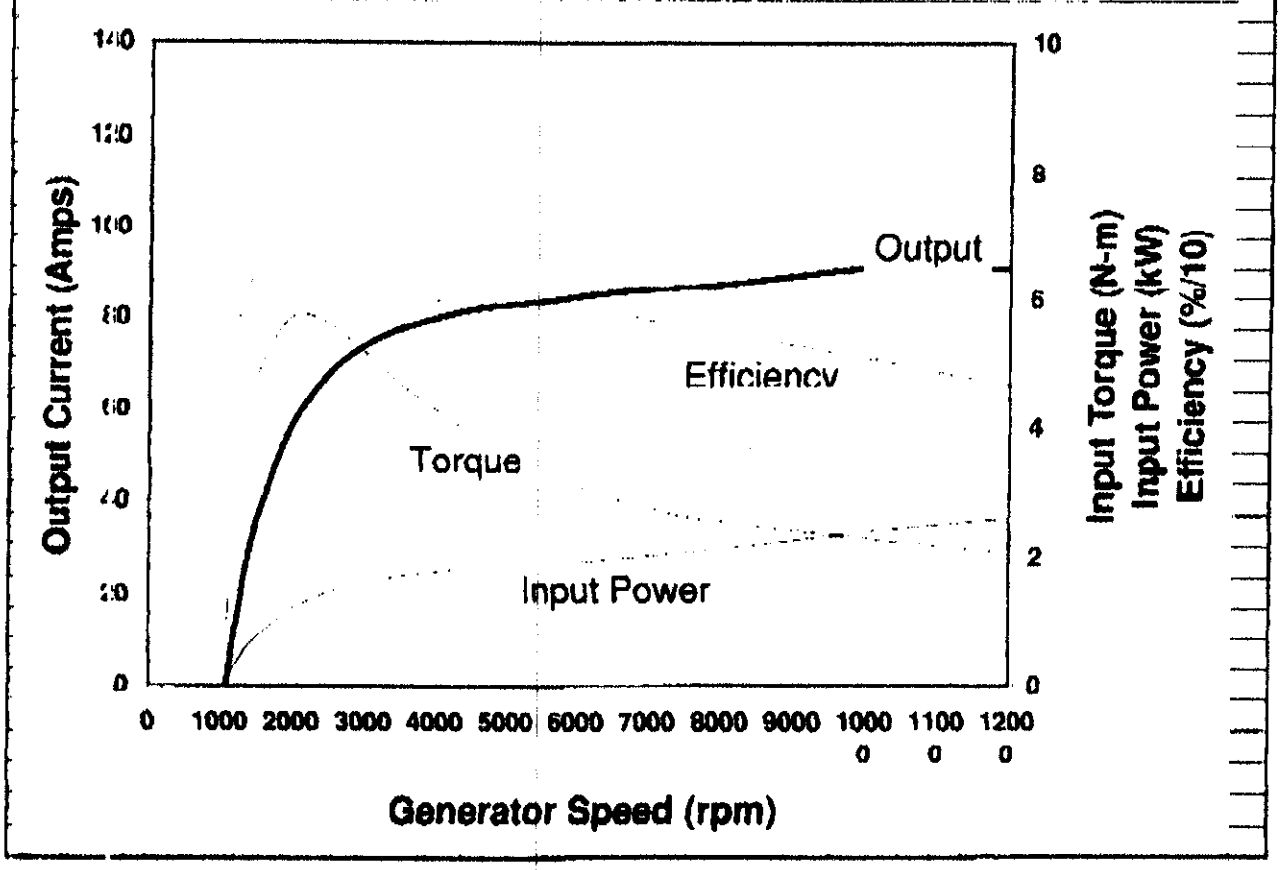
105C CURVE

K5901364		13.25 V		105 C				02DE98
	Shaft Speed (grpm)	Output Current (amps)	Field Current (amps)	Input Torque (lb-in)	Input Torque (N-m)	Input Power (kW)	Output Power (watts)	Generator Efficiency (%/10)
Cut-In >	1044	0.0	3.89	9.8	1.11	0.1210	0.0	0
2 Amp >	1063	2.0	3.88	12.4	1.40	0.1559	26.5	1.699
	1200	18.8	3.87	30.8	3.48	0.4373	249.1	5.697
	1400	37.1	3.85	47.5	5.37	0.7868	491.6	6.248
	1600	49.4	3.84	55.6	6.28	1.0525	654.6	6.219
	2000	66.7	3.84	61.8	6.98	1.4623	883.8	6.044
	2500	79.1	3.87	60.3	6.81	1.7835	1048.1	5.876
	3000	85.9	3.91	55.7	6.29	1.9770	1138.2	5.757
	3500	90.3	3.95	50.8	5.74	2.1036	1196.5	5.688
	4500	95.7	4.01	42.7	4.82	2.2734	1268.0	5.578
	5500	98.8	4.05	36.8	4.16	2.3946	1309.1	5.467
	6500	100.9	4.09	32.5	3.67	2.4993	1336.9	5.349
	8000	102.6	4.09	28.1	3.17	2.6596	1359.5	5.111
	10000	103.8	4.10	24.3	2.75	2.8750	1375.4	4.784
	12000	104.4	4.08	22.1	2.50	3.1376	1383.3	4.409
	15000	105.0	4.07	20.8	2.35	3.6913	1391.3	3.769



125C CURVE

K590364	13.25 V	125 C					02DE98
	Shaft Speed (grpm)	Output Current (amps)	Field Current (amps)	Input Torque (lb-in)	Input Torque (N-m)	Input Power (kW)	Output Power (watts)	Generator Efficiency (%/10)
Cut-In >	1074	0.0	3.52	8.9	1.01	0.1131	0.0	0
2 Amp >	1095	1.7	3.44	10.6	1.20	0.1373	22.5	1.640
	1200	12.4	3.40	22.0	2.49	0.3123	164.3	5.260
	1400	29.8	3.42	37.9	4.28	0.6278	394.9	6.290
	1600	40.6	3.32	44.6	5.04	0.8443	538.0	6.372
	2000	56.7	3.33	50.7	5.73	1.1997	751.3	6.262
	2500	67.7	3.34	49.5	5.59	1.4641	897.0	6.127
	3000	73.9	3.35	45.6	5.15	1.6185	979.2	6.050
	3500	77.6	3.36	41.3	4.67	1.7102	1028.2	6.012
	4500	81.8	3.38	34.4	3.89	1.8315	1083.9	5.918
	5500	83.6	3.37	29.2	3.30	1.9001	1107.7	5.830
	6500	85.6	3.40	25.6	2.89	1.9687	1134.2	5.761
	8000	87.5	3.43	22.4	2.53	2.1201	1159.4	5.468
	10000	91.1	3.57	20.1	2.27	2.3781	1207.1	5.076
	12000	91.0	3.50	18.2	2.06	2.5839	1205.8	4.666
	15000	95.7	3.70	18.0	2.03	3.1944	1268.0	3.970



C-8244
"CZ" laboratory test order was K590364
Generator was model 10480341 (10480327 w/overrunning pulley).
Generator #29 was selected as representative of the nominal of 30 units tested on K590296.
Generator #29 was built with production parts in plant 4 on 24AP98.
The segments were CFPT design 1 trap (version F) made with steel near the upper thickness limit.
The segments were not machined "flat" on the inside face.
The rotor field coil consisted of 315 turns of 19.25 AWG wire.
"CZ" testing was performed on stand #5 during the month of September 1998.